closed, and a bio-compatible fluid is injected through the fluid entrance valve **3706**. The fluid carries big cells are flushed out from exit B. The larger cells are then analyzed and detected in the detection part of the invention.

FIG. **38** is a diagram of a pre-processing unit of an apparatus of this invention. This unit includes a sample filtration unit, a recharging unit or system for recharging nutrient or gas into the biological subject, a constant pressure delivery unit, and a sample pre-probing disturbing unit.

FIG. **39** is a diagram of an information or signal processing unit of an apparatus of this invention. This unit includes an amplifier (such as a lock-in amplifier) for amplifying the signal, an A/D converter, and a micro-computer (e.g., a device containing a computer chip or information processing sub-device), a manipulator, a display, and network connections.

FIG. **40** shows the integration of multiple signals which results in cancellation of noise and enhancement of signal/noise ratio. In this figure, a biological **4001** is tested by Probe 1 during Δt between t1 and t2, and by Probe 2 during Δt between t3 and t4. **4002** is **4001**'s tested signal from Probe 1, and **4003** is from Probe 2. Signal **4004** is the integration result from signal **4002** and **4003**. The noise cancels out each other in certain extent and results in an improved signal strength or signal/noise ratio. The same principle can be applied to data collected from more than more than 2 micro-devices or probing units.

The micro-devices described herein, as well as some of the detection parameters and properties and processes described herein, have been used for tests on cancerous samples (e.g., liver cancer samples and breast cancer samples) and controls (i.e., noncancerous or normal samples). While these samples were not CTC samples, the tests nonetheless were relevant to this invention and indicative of the invention claimed herein as they showed advantages and improvements (for example, improved signal sensitivity) in cancer detection which will be very beneficial for CTC detections. Further, these tests have proved the concept of enhancing cancer detection signals and efficiency which is very applicable to CTC. In one set of experiments, use of the micro-devices and test parameters described herein resulted in enhanced measurement signal compared to a currently known method based on genomic analysis. Specifically, even after diluting the original cancer cell samples by over 20 times, signals differentiating the cancer cells from the normal sample were still detected. By comparison, a recently reported genomic analysis detected signal of a cancer sample that was diluted only about 5 times. The tested micro-devices, associated testing parameters, cancer and normal cell properties, and testing methodologies described herein have all showed high degree of measurement sensitivity, reliability, and repeatability.

Additional tests were carried out in the laboratory with the micro-devices described herein on certain cancerous tissue samples (with multiple samples for each type of cancer) although the micro-devices can be used for detection of other types of cancer or other types of treatment. In the tests, healthy control samples were obtained from animals with no known cancer disease at the time of collection and no history of malignant disease. Both cancerous samples and healthy control samples were collected and cultured in the same type of culture solution. The cultured samples were then mixed with a dilution buffer and diluted to the same concentration. The diluted samples were maintained at the room temperature for different time intervals and processed within a maximum of 6 hours after being recovered. The diluted samples were tested at the room temperature (20~23° C.) and in the humidity of 30%~40%. The samples were tested with a micro-device of this invention under the same conditions and stimulated by the same pulse signal.

The test results show that, in general, the control groups' tested (measured) values (i.e., measured values in relative units for the testing parameter) were lower than the cancerous or diseased groups. Under the same stimulation (in terms of stimulation type and level) with a stimulating or probing signal applied by a probing unit of the tested micro-devices the difference shown in the measured values between the control groups and the cancerous groups became much more significant, e.g., ranging from 1.5 times to almost 8 times in terms of level of increase in such difference, compared with that without simulation. In other words, the cancerous groups' response to the stimulating signal was much higher than that of the control groups. Thus, the tested micro-devices have been proven to be able to significantly enhance the relative sensitivity and specificity in the detection and measurement of diseased cells, in comparison to the control or healthy cells.

Further, the test results show that in terms of the novel parameter utilized by the micro-device of this invention, the cancerous group and the control group showed significantly different response. Such difference is significantly greater than the measurement noise. There was a large window to separate the control groups from the cancerous groups, showing a high degree of sensitivity of the novel measurement method and apparatus.

Although specific embodiments of this invention have been illustrated herein, it will be appreciated by those skilled in the art that any modifications and variations can be made without departing from the spirit of the invention. The examples and illustrations above are not intended to limit the scope of this invention. Any combination of detection apparatus, micro-devices, fabrication processes, flow sequence, and applications of this invention, along with any obvious their extension or analogs, are within the scope of this invention. Further, it is intended that this invention encompass any arrangement, which is calculated to achieve that same purpose, and all such variations and modifications as fall within the scope of the appended claims.

All publications referred to above are incorporated herein by reference in their entireties. All the features disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example of a generic series of equivalent or similar features.

Other Embodiments

It is to be understood that while the invention has been described in conjunction with the detailed description thereof and accompanying figures, the foregoing description and accompanying figures are only intended to illustrate, and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims. All publications referenced herein are incorporated by reference in their entireties.

What is claimed is:

1. An apparatus for detecting tumor cells in a biological subject, comprising a system for delivering the biological subject and a probing and detecting device;

wherein the system for delivering the biological subject comprises a channel or a chamber;